Sprint

Luisa L. Lancetti
Vice President
Regulatory Affairs - PCS

401 9th Street, NW, Suite 400
Washington, DC 20004
Voice 202 585 1923
Fax 202 585 1892

January 30, 2002

Ms. Magalie Salas, Secretary
Federal Communications Commission
445 12th Street SW
Washington, D.C. 20554

Re: ***Written Ex Parte Communication***
Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems -- ET Docket No. 98-153

Dear Ms. Salas:

Sprint Spectrum L.P., d/b/a Sprint PCS ("Sprint PCS"), submits this *ex parte* response to the letter that XtremeSpectrum, Inc. filed in this docket on January 3, 2002. [1] In that letter, XtremeSprectrum acknowledges that the PCS/UWB interference tests and the Telcordia model Sprint PCS and Time Domain jointly commissioned are "well designed and carried out," but asserts that the Commission should ignore the results of this work (as well as tests conducted by Qualcomm reaching similar results) because, it claims, the tests used the "wrong" assumptions.[2]

Sprint PCS demonstrates below that XtremeSpectrum's criticism of the assumptions used in the joint Sprint PCS/Time Domain tests lacks merit. Sprint PCS also submits additional studies and analyses that further refute other assertions XtremeSpectrum makes regarding UWB devices. This additional testing data documents that XtremeSprectum's unsupported assertions to the Commission — UWB presents a "far lower interference threat than any other Part 15 device" and its proposed emission levels would "fully resolve all interference issues" raised by PCS — are false.

Given the record evidence to date demonstrating that UWB emissions cause harmful interference to PCS services, the Commission should not authorize UWB in the 1.9 GHz PCS band or any other bands that it may allocate in the future to commercial mobile radio services ("CMRS"). In addition, given Qualcomm's recent testing of the harmful interference from UWB emissions to gpsOne, the E911 technology that Sprint PCS and other carriers are deploying in order to meet the Commission's Phase II E911 mandate, the Commission should also not permit use of UWB emissions in the GPS band. [3]

---

[1] Letter from Mitchell Lazarus, Counsel for XtremeSpectrum, to Magalie Salas, FCC Secretary, Docket No. 98-153 (Jan. 3, 2002)("XtremeSpectrum Ex Parte").

[2] *Id.* at 2 and 4.

[3] Sprint PCS notes that the Department of Defense has taken the position that to "protect critical Defense systems," UWB should not be authorized "below 4.2 GHz, except for imaging systems." The DoD further recognizes that other agencies operate critical systems above 4.2 GHz (up to 6 GHz) which also re-

It is noteworthy that although UWB proponents have the burden of demonstrating that their proposed services will not cause harmful interference to existing licensees, no UWB proponent, other than Time Domain as part of the joint tests with Sprint PCS, has conducted UWB/PCS interference tests. Moreover, all studies conducted to date have demonstrated the existence of interference. Indeed, one major UWB proponent, Multispectral Solutions ("MSSI") has acknowledged that UWB will cause "significant" interference to PCS networks:[4]

> Unfortunately, while some UWB advocates have claimed that UWB operates in the "garbage band" and can superimpose its emissions on existing services without interference thereby "creating spectrum," such statements are without basis in fact and, in fact, have shown to be false.[5]

In fact, last week MSSI announced that it "strongly supports the Department of Defense position . . . that unlicensed UWB emissions must be completely restricted from frequencies below 4.2 GHz."[6]

Wideband Devices Cannot Be Evaluated on a Narrowband Basis

XtremeSpectrum and certain other UWB proponents regularly assert that the power generated by their devices is substantially below the power levels permitted by Part 15:

> UWB presents a far lower interference threat than any other Part 15 device, whether intentional or unintentional. Both the Commission's NPRM and XtremeSpectrum's proposal limit UWB emissions in the PCS band to just 6 percent of the power permitted for hundreds of millions of consumer digital devices.[7]

These statements are at best misleading. Part 15 devices generate power in narrow frequency ranges and rarely operate close to the power levels permitted by Part 15. As demonstrated in testing described below, current Part 15 devices are generally not detectable in PCS bands.

By definition, however, wideband devices like UWB generate power over several gigahertz of spectrum, including the PCS bands, and they will presumably operate near the maximum

---

quire protection. Letter from John P. Stenbit, Assistant Secretary of Defense, to Michael D. Gallagher, Deputy Assistant Secretary of Commerce for Communications and Information (Jan. 11, 2002). Sprint PCS is aware of similar concerns of harmful interference to various other services such that the FCC can provide adequate protection to all existing services by limiting UWB emissions to above 6 GHz.

[4] *See, e.g.,* MSSI Comments, Docket No. 98-153, at 10-12 (Sept. 12, 2000); MSSI Reply Comments, Docket No. 98-153, at 2 (March 6, 2001); MSSI Reply Comments, Docket No. 98-153, at 2-3 (Feb. 22, 2001); MSSI Reply Comments, Docket No. 98-153, at 2 (Oct. 25, 2000).

[5] MSSI Comments, Docket No. 98-153, at 12 (Sept. 12, 2000).

[6] Letter from Robert J. Fontana, MSSI President, to Magalie Roman Salas, FCC Secretary, Docket No. 98-153, at 1 (Jan. 25, 2002).

[7] XtremeSpectrum Ex Parte at 15.

power levels they propose. Accordingly, to determine the impact of power generation by a UWB device, the total power generated across the spectrum range must be evaluated.

CDMA uses spectrum efficiently in part because of its use of widebands of spectrum to act as a single carrier of information. Current CDMA (IS-95) uses 1.25 MHz channels for transmission. This broad range of spectrum allows CDMA to overcome temporary spikes of power within its frequency range. Ultra-wideband devices, however, will generate power across the entire licensed band of spectrum used by PCS providers.

Once viewed in perspective, it is clear that UWB devices are *not* generating less power than a typical Part 15 device as certain parties maintain, but in fact are generating much greater power and interference. It is essential the Commission not be mislead into comparing "apples with oranges" in ways that will undermine the provision of critical services to the public.

The Personal Computer Red Herring

XtremeSpectrum continues to represent to the Commission that UWB devices use less power than personal computers, laptops, and other digital devices.[8] Because PCS handsets can operate in the vicinity of PCs, they argue, UWB devices could not possibly cause interference. The discussion above should help clarify why this argument is both wrong and seriously misleading.

Personal computers may generate spikes of power in certain frequency ranges, but they do not broadcast across an entire megahertz of spectrum and rarely, if ever, generate power in the PCS bands. To demonstrate the relative impact of UWB devices and personal computers, Sprint PCS measured the actual power generated by a 2 GHz desktop computer.[9] These tests showed that when its cover is on, a 2 GHz computer operates below the noise floor and does not even radiate sufficient energy to be detected by standard testing equipment. Even with the cover removed, the computer operates at 32 dB below current Part 15 levels in the PCS bands.

Appendix A (Test Series 2) is a more detailed description of certain tests Sprint PCS conducted to address the arguments raised by various UWB proponents. Included in that presentation are several tables that graphically demonstrate the measurable RF emissions of a 2 GHz computer. Figure 12 shows the relative carrier-to-interference ratio generated by such a computer and a UWB device operating at power levels both at current Part 15 unintentional radiator levels and at –12 dBm below as discussed in the FCC's NPRM. The computer has no measurable effect on the carrier-to-interference ratio, and it operates below the noise floor. In contrast, the UWB emission levels show a substantial impact in the PCS frequency band. To state the results in more practical terms, the UWB emissions will cause harmful interference to PCS devices

---

[8] *See, e.g.,* XtremeSpectrum Ex Parte at 2 ("[P]ersonal computers, laptops, and other digital devices are allowed 16 times more power in the PCS band than is UWB.").

[9] Sprint PCS chose a 2 GHz computer because it is the most likely to generate RF emissions in the PCS bands of 1.9 GHz. As computer speeds increase to 3 and 4 GHz, the potential for interference to PCS bands diminishes rapidly.

and will result in a significant loss of capacity and result in increased call blocking and increased dropped calls.

Impact on the Noise Floor of UWB Versus Other Part 15 Devices

XtremeSpectrum argues that PCS carriers have not addressed the impact of existing Part 15 devices on the noise floor.[10] To address this argument directly, Sprint PCS conducted a series of tests of a typical office environment to document the relative effect of Part 15 devices, both intentional and unintentional radiators.

Appendix A (Test Series 1) is a study showing the actual noise floor in a typical office environment in the PCS bands. Measurements were taken at three different times of day: during the morning and afternoon, when Part 15 devices are active, and again in the evening, when Part 15 devices are not operating. In order to ensure that maximum power was measured, the recordings were made in three different locations: (1) within three meters of an 802.11 device, (2) within three meters of a laptop computer, and (3) within three meters of a microwave oven.

The results demonstrate that current Part 15 devices generate power well below current Part 15 permitted levels and have no impact on the noise floor in the PCS bands. The only measured power detected in these tests was that generated by PCS carriers operating in their licensed spectrum.[11] The power generated by these Part 15 devices was so far below permitted levels that they did not even register on the test equipment. By contrast, if UWB devices were allowed to operate at Part 15 levels, there would be substantial impact on the carrier-to-noise ratio of any PCS network. Figure 8 is a graphic representation of the decreased carrier-to-interference ratio associated with an increase in the noise floor due to an operating UWB device.

UWB/PCS Interference Tests Have Used Reasonable Assumptions and Have Yielded Uniform Results – Harmful Interference to PCS Operations

All testing of UWB devices conducted to date has demonstrated the existence of interference. More specifically, tests of the impact of UWB devices on PCS networks have documented an adverse effect on capacity, dropped and blocked calls.[12] These test results are supported by a model that Telcordia prepared at the joint request of Sprint PCS and Time Domain.[13] Time Do-

---

[10] *See* XtremeSpectrum Ex Parte at 6-7.

[11] This result is demonstrated most graphically in Figure 8 by the lack of activity in the PCS Band C, which is not currently being used in Kansas City.

[12] *See* Qualcomm Report (March 5, 2001); Jay Padgett, A Model for Calculating the Effect of UWB Interference on a CDMA PCS System (September 12, 2000); Summary of Testing Performed by Sprint PCS and Time Domain to Characterize the Effect of Ultra Wideband (UWB) Devices on an IS-95 PCS System (September 12, 2000). *See also* Qualcomm Report (Jan. 14, 2002)(UWB interference on E911 location systems)

[13] *See* Dr. Jay Padgett, Senior Research Scientist, Telcordia Technologies, "A Model for Calculating the Effect of UWB Interference on a CDMA PCS Systems" (Sept. 12, 2000), *appended as* Attachment 1 to the September 12, 2000 Sprint PCS and Time Domain letters.

main has acknowledged that this Telcordia model it commissioned is an "excellent theoretical analysis" and that the anechoic chamber tests "confirm the model's predictions."[14]

Notwithstanding that this work consistently demonstrates that UWB devices cause interference with PCS systems, UWB proponents continue to deny the existence of a problem. Rather than providing contrary test data, however, these advocates rely on spin control and misinterpretations of existing test data.[15] Most recently, XtremeSpectrum purported to identify five "wrong" assumptions in the previous testing in an attempt to explain away the evidence of interference. However, contrary to XtremeSpectrum's claims, none of its explanations undermine the validity of the results of the Sprint PCS/Time Domain tests, as demonstrated below.

1. The Emission Limits Used in the Sprint PCS Study Were Appropriate

XtremeSpectrum first asserts that "most" PCS studies were based on UWB emission levels "much higher than any proposals before the Commission."[16] However, it admits that "Sprint PCS . . . predict[ed] harmful interference into PCS from UWB devices operating at the NPRM level (12 dB below Class B)."[17] Accordingly, there are no grounds for distinguishing Sprint PCS' testing on this basis.

2. Sprint PCS Used a Conservative Estimate of the Number of UWB devices

XtremeSpectrum next asserts that "PCS studies assume extremely large numbers of UWB devices, ranging up to 5,000 to 100,000 active emitters per square kilometer."[18] This assertion is false, for the Sprint PCS testing made no such assumption. Time Domain provided only one device for testing and the results were based on this one device. The Telcordia Model, which extrapolated the expected impact of UWB devices based on the test results, assumed only that two to nine handsets within a cell site coverage area were within two to four meters of an operating UWB device. Given that a base station can cover more than a two-mile radius and handle over 50 simultaneous users, this was a conservative assumption.

---

[14] Time Domain Reply Comments, Docket No. 98-153, at 39 (Oct. 27, 2000). Although Time Domain asserts that "real world" tests differed from the model's predictions (*id.*), the scientist that Time Domain retained does not share this view. *See* Telcordia Model at 4-5.

[15] UWB proponents have refused to provide UWB devices for additional testing. Accordingly, arguments that PCS providers have done insufficient testing (*e.g.,* not provided the interference effects of multiple UWB devices in an area) ring hollow.

[16] XtremeSpectrum Ex Parte at 5.

[17] *Id.*

[18] *Id.*

3. Current Part 15 Devices Do Not Impact the Noise Floor in the PCS Spectrum

XtremeSpectrum would have the Commission assume that all Part 15 devices operate at maximum power and in all frequency ranges and that as a result, UWB emissions "will always be well below ambient radio noise in the PCS band."

> [B]ecause UWB operates at a far lower permitted power level than a personal computer, it will have a far smaller effect on a PCS handset's power demands, most typically, none at all.[19]

XtremeSpectrum does not submit a single piece of evidence in support of these sweeping conclusions.

The Sprint PCS testing discussed above documents that XtremeSpectrum's assertions are false. Current Part 15 devices rarely operate at their maximum permitted power or across a wide band of spectrum. Measurements of the general ambient noise in typical office environment show that Part 15 devices do not even register in the PCS bands.

Moreover, the examples XtremeSpectrum recites are extremely misleading. While microwave ovens and wireless LANs may be permitted to operate at 400 to 2800 times more power than UWB devices, they are restricted to the 2.4 GHz band of spectrum to avoid interference with licensed services. The power level is irrelevant because, unlike UWB devices, they are not likely to be generating power in the PCS band. Again, it is essential the Commission not be misled into comparing apples with oranges.

4. Propagation is Not an Issue at Four Meters

XtremeSpectrum argues that the Sprint PCS/Time Domain tests are invalid because they do not measure the impact of interior walls and furniture.[20] The interference demonstrated by the Sprint PCS/Time Domain tests, however, is at one-to-four meters.[21] There are not likely to be many walls or pieces of furniture between the UWB LAN device or UWB telephone and the PCS customer when they are within four meters. The average conference room or office cubicle would be considerably smaller than eight square meters. Multiple UWB devices, without any walls or furniture to diminish the interference, could distort this free space. This argument also highlights the weakness of the UWB proponents' case. They are suggesting that the FCC should rely on the placement of sufficient office furniture to protect licensed users. This cannot be considered rational decision-making.

---

[19] *Id.* at 7 and 10 n.27..

[20] *See id.* at 7.

[21] However, Qualcomm's recent gpsOne interference study documented that UWB devices can disable Phase II E911 location capabilities at distances far further than four meters.

5. Aggregation was not part of the Sprint PCS/Time Domain Tests

XtremeSpectrum finally asserts that the "PCS studies assume that signals from multiple UWB units aggregate to form stronger signals."[22] This assertion is also false. The Sprint PCS/Time Domain study evaluated the impacts of only one UWB device because Time Domain made only one device available for testing. Sprint PCS demonstrated substantial impacts without regard to aggregation. While it recognizes that the largest impact from UWB devices will occur from the nearest device, Sprint PCS also agrees with NTIA, Intel and others that the impact of multiple UWB devices in an area will be far worse than the impact of only one UWB device.[23]

In fact, it is XtremeSpectrum's arguments that are based on inappropriate assumptions. XtremeSpectrum asks the Commission to assume that all UWB devices are more than 100 meters away from a PCS device.[24] This simply assumes away the problem. The issue is what happens when multiple UWB devices are within the same five-by-five meter cubicle.

In summary, although XtremeSpectrum criticizes the Sprint PCS/Time Domain tests as containing "wrong" assumptions, closer examination reveals that it is XtremeSpectrum's criticism that lacks merit.

Government Liability for Breach of Contract

XtremeSpectrum criticizes Sprint PCS for offering "no legal support" for the suggestion that the Government could be liable in damages for the costs Sprint PCS would incur to overcome UWB interference, but then offers "no legal support" for its assertion that the Government need not worry because, XtremeSpectrum says, it would face no damage liability.[25]

Sprint PCS has provided legal support for its position in the record.[26] Sprint PCS paid approximately $3.5 billion to acquire and clear its PCS spectrum, and it has invested another $12 billion in constructing its nationwide, state-of-the-art, CDMA network. Sprint PCS made this massive investment with the express understanding that it would, as the FCC has stated, hold "an exclusive right to use the designated portion of the electromagnetic spectrum for the term of the license."[27]

---

[22] *See id.*

[23] *See, e.g.,* Intel Reply Comments, Docket No. 98-153, at 20 (Oct. 27, 2000)("The aggregation of several UWB devices in the same area could have the potential of further increasing the noise floor of operating devices in the same frequency. . . . The additional interference will either reduce the acceptable operational distances of other wireless devices or impact the available link margin and potentially impact the perceived performance levels.").

[24] *See* XtremeSpectrum Ex Parte at 3 n.4.

[25] *See* XtremeSpectrum Ex Parte at 14.

[26] *See* Sprint PCS Written Ex Parte Presentation, ET Docket No. 98-153 (Feb. 21, 2001).

[27] *Public Utility Commission of Texas,* 13 FCC Rcd 3460, 3503 ¶ 89 (1997).

In sum, Sprint PCS respectfully submits that, having received valuable consideration for issuing exclusive licenses, the Commission does not now have the legal right to convert these licenses into non-exclusive licenses and to require Sprint PCS to share its spectrum with others, much less share its spectrum for free. And the Commission cannot impose mandates on Sprint PCS (*e.g.*, E911 location requirements), and then take steps that inhibit Sprint PCS' ability to meet the mandates.

Given that the federal government has received valuable (and sizable) consideration for issuing PCS licenses, these licenses have effectively become a contract between the government and the licensee. The Supreme Court has repeatedly held in recent years that the government becomes liable if it breaches its contracts.[28]

UWB Devices Threaten the Operation of New E911 Technology

In 1996, the FCC imposed strict new requirements for the provision of 911 services on wireless networks. Although no technology existed at that time that would perform this caller location function sought by public safety, CMRS carriers committed to find a means of locating wireless phones within 100 meters. The Commission later tightened the accuracy requirement to 50 meters for handset-based location systems.

After years of research and development, hundreds of millions of dollars of investment and tens of thousands of man-hours, carriers are now deploying some of the most sophisticated locating equipment ever developed. The most accurate technology (as well as the most widely adopted technology for CDMA carriers) is that developed by Snaptrack in conjunction with Qualcomm known as gpsOne. This system relies upon both GPS signal information and information collected within the PCS carrier's network. The accuracy of this system, however, depends upon receipt of GPS information at the individual's handset. As demonstrated in a recent Qualcomm filing, the operation of this system will be negatively effected if UWB transmitters are permitted to operate in a ubiquitous manner.[29]

Conclusion

XtremeSpectrum represented to the Commission only last week that UWB emission levels in the PCS bands of –12 dB for fixed UWB devices and –16 dB for portable UWB devices would "fully resolve all interference issues raised by GPS, PCS, E-911 [and] public safety."[30] Not a single study supports this assertion, and in fact, every study performed do date contradicts XtremeSpectrum's claims.

---

[28] *See, e.g., Mobile Oil* v. *United States*, No. 99-244 (June 26, 2000); *United States* v. *Winstar*, 518 U.S. 839 (1996).

[29] *See* Qualcomm Written Ex Parte Communication, Docket 98-253 (Jan. 11, 2002).

[30] Letter from Mitchell Lazarus, Counsel for XtremeSpectrum, to Magalie Salas, FCC Secretary, Docket No. 98-153, at 2 (Jan. 25, 2002).

UWB devices have consistently been demonstrated to cause interference with PCS networks and should not be approved in the PCS band, any other band that the Commission may designate for commercial mobile radio services, or the GPS band.[31]

Pursuant to Section 1.1206(a), this presentation is being electronically filed with your office. Please associate this letter with the file in the above-captioned proceeding.

Sincerely,

Luisa L. Lancetti
Vice President, PCS Regulatory Affairs
401 9th Street, N.W., Suite 400
Washington, D.C. 20004
202-585-1923

Charles W. McKee
General Attorney, Sprint PCS
6160 Sprint Parkway
Mail Stop: KSOPHI0414-4A325
Overland Park, KS 66251
913-762-7720

Attachment: Ambient Office Noise/Personal Computers and the Relative Impact of UWB Devices

cc: Chairman Michael K. Powell
Commissioners Kathleen Q. Abernathy
Commissioner Michael J. Copps
Commissioner Kevin J. Martin
Secretary of Transportation Norman Mineta
Deputy Assistant Secretary of Commerce Michael Gallagher
Assistance Secretary of Defense John Stenbit
Thomas J. Sugrue, Chief, WTB
Peter Tenhula, Senior Legal Advisor, Office of Chairman Powell
Bryan Tramont, Senior Legal Advisor, Office of Commissioner Abernathy
Paul Margie, Legal Advisor, Office of Commissioner Copps
Monica Desai, Legal Advisor, Office of Commissioner Martin
Bruce Franca, Acting Chief, OET
Julius P. Knapp, Deputy Chief, OET
Michael Marcus, Associated Chief of Technology, OET
Lisa Gaisford, Assistant Chief of Management, OET

[31] *See* n. 3 *supra.*

Karen E. Rackley, Chief, Technical Rules Branch, OET
John A. Reed, Senior Engineer, Technical Rules Branch, OET
Mitchell Lazarus, Counsel, XtremeSpectrum

AMBIENT OFFICE NOISE/ PERSONAL COMPUTERS

AND

THE RELATIVE IMPACT OF UWB DEVICES

Sprint PCS

FCC Docket No. 98-153

January 18, 2002

Purpose/Summary

Sprint PCS conducted two sets of tests to measure the relative impact of UWB devices and Part 15 intentional and unintentional radiators on the PCS frequency band.

The purpose of the first set of tests was to measure the amount of ambient noise rise over the established noise floor in a typical office environment during different hours of the day, with different devices (computers, printers, microwave ovens, wireless telephones), all in operation. The results of these measurements are used to show that current Part 15 unintentional radiators, as well as some intentional radiators (*e.g.,* wireless LANs), operate well below those levels that cause interference with PCS networks and well below the power levels permitted by Part 15. In fact, these devices do not register in the PCS bands.

A second set of tests was conducted to demonstrate the level of interference created by a 2GHz personal computer. These measurements show that such computers create no interference with PCS networks and operate well below Part 15 unintentional radiator limits. Even with the cover of the device removed, the 2GHz computer operated at 32 dB below Part 15 allowed levels in the PCS bands.

These test results are then compared with the relative impact of a UWB device at the two emissions levels (-41.2 dBm/MHz and –53.2 dBm/MHz) discussed in the FCC's NPRM with the received power levels that would be measured at three meters from the UWB device. The impact of a UWB device is shown in comparison to the ambient noise measured and the radiated energy of a 2GHz computer. The data show a negative impact to the measured PCS noise floor by increasing the noise floor by 13 dB at –53.2 dBm and by 24 dB at –41.2 dBm. An increase in the noise floor at these levels would result in a decrease in PCS air interface capacity and increase the probability of dropped calls. In short, UWB interference would deteriorate the quality of existing PCS services.

Test Series 1 – Ambient Noise

Data Collection Setup

Figure 1 is a set up for the measurement of ambient noise. A spectrum analyzer configured to measure power using a 1MHz resolution bandwidth is connected to a low noise amplifier (LNA) that has a nominal noise figure of 1.5dB and 38dB of signal gain and a pass band filter from 1.7GHz to 2.4GHz. The LNA is then connected to a passive antenna that has been tuned for the PCS signal band ranging from 1850MHz to 1990MHz.

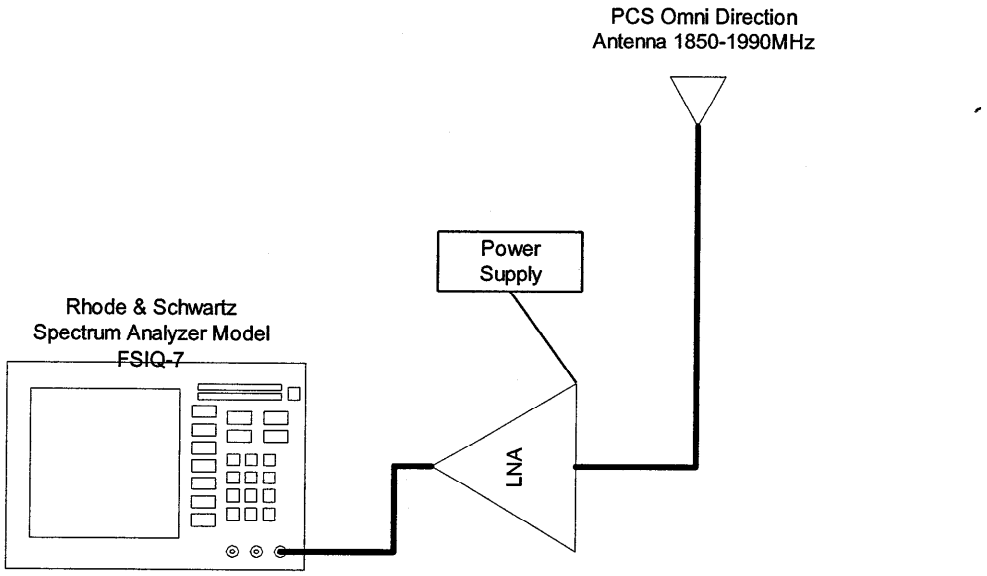

Figure 1: Setup used to measure signal power in the PCS spectrum

Environment

Data collection for this project was performed on January 9, 2002. The data was collected inside a Sprint PCS building located in Lenexa, KS. The building houses groups that comprise the Sprint PCS Technology and Advanced System Development Group. The building contains three laboratories and houses approximately 200 people. Signal measurements were made in three locations (indicated by the red stars on Figure 2) at three different times of the day (morning, afternoon and evening). The three locations identified as having the potential for the highest amount of interference were: (1) an area in the break room with the data collection equipment located within three meters of a microwave oven; (2) inside an associate's work space in which a Toshiba Tecra 8100 Laptop Computer and a Dell 800MHz Desk Top Computer, Palm VII PDA and a PCS mobile terminal were operating; (3) under an 802.11b wireless LAN access point.

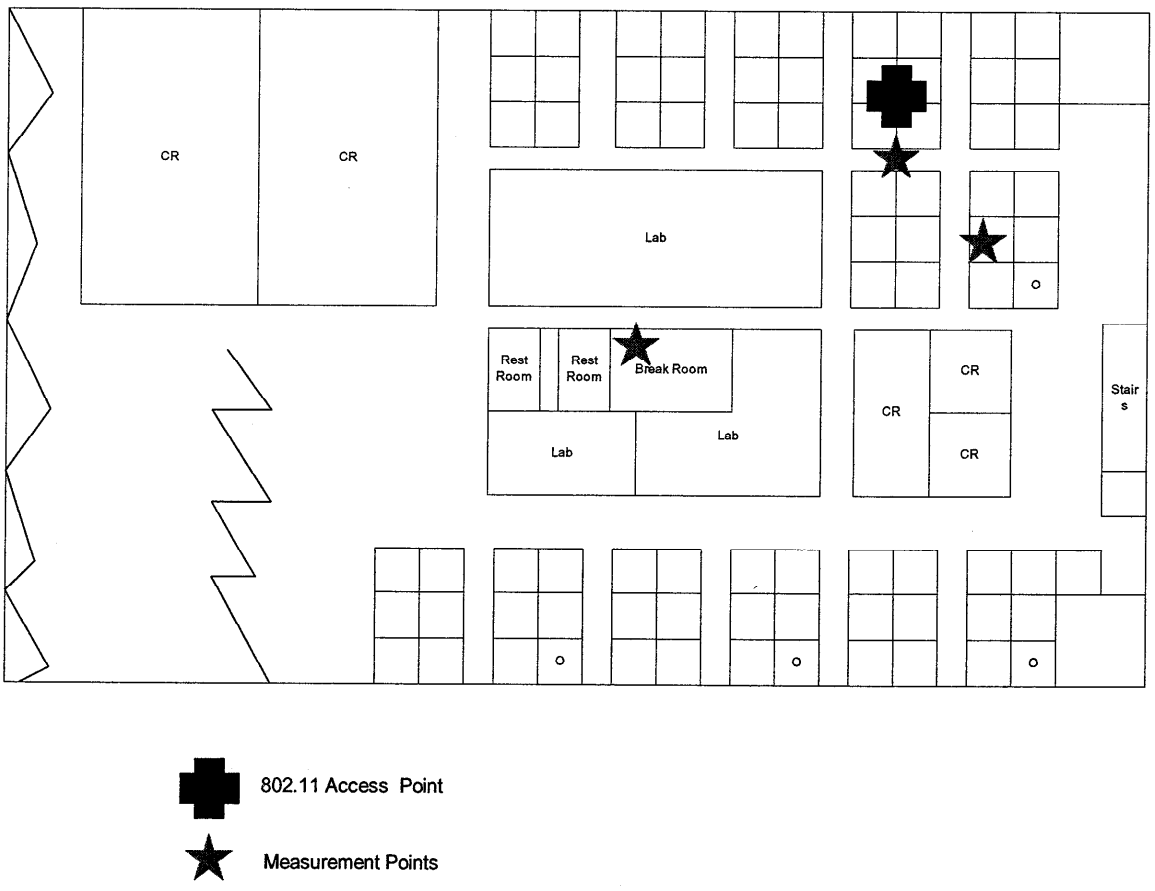

Figure 2 Data collection points for measurement of ambient noise

Results of the Data Collection

The first chart presented (Figure 3) shows the results of the baseline measurements of the equipment. This measurement was made inside a Lundgren isolation chamber that provides 120dB of RF insulation. This establishes a baseline for all the subsequent measurements to be made as well as calculated values used for later charts.

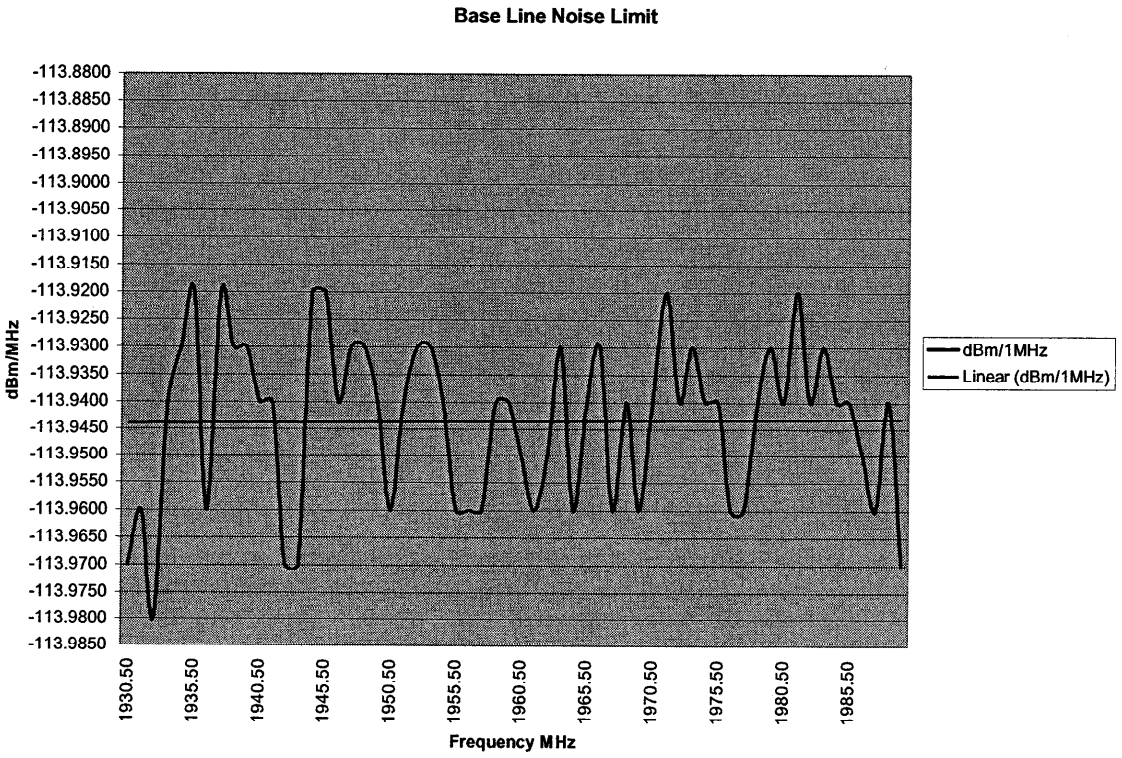

Figure 3: Baseline equipment noise floor with an average -113.9435dBm/MHz

The charts presented in Figures 4, 5, 6 and 7 are remarkably similar and show variation only in the licensed operator's signals that correspond to wireless mobile services in the Kansas City area. Other variations in the presence of devices that operate under FCC Part 15 regulations do not even show up in the 60 MHz of spectrum in which these measurements were made. The most compelling evidence is presented in the PCS C-Band where there is no active operator in the greater Kansas City area. The charts show that the ambient noise measured in the office environment is essentially at the same levels as the base line measurement and is on average within $\pm$ 0.56dB with a mean difference of .96dB. The important fact to be noted is that while the ambient noise is above the baseline, it never approaches the –53.2 dBm limits discussed in the FCC's NPRM for UWB devices.

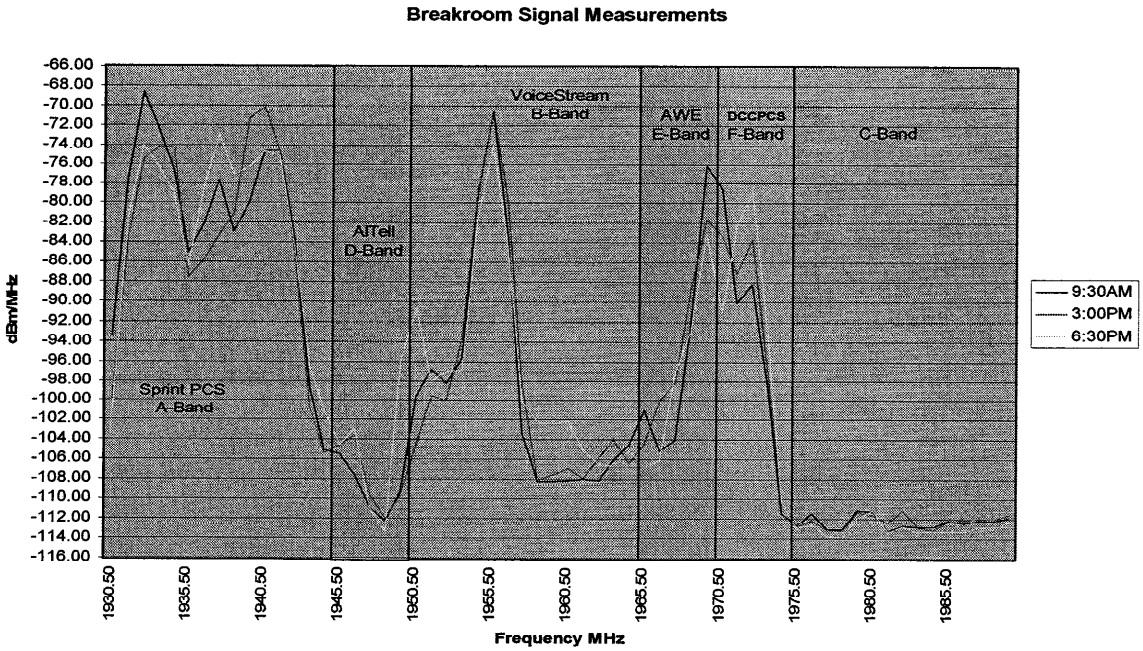

Figure 4: RF signals measured in WS1 Breakroom

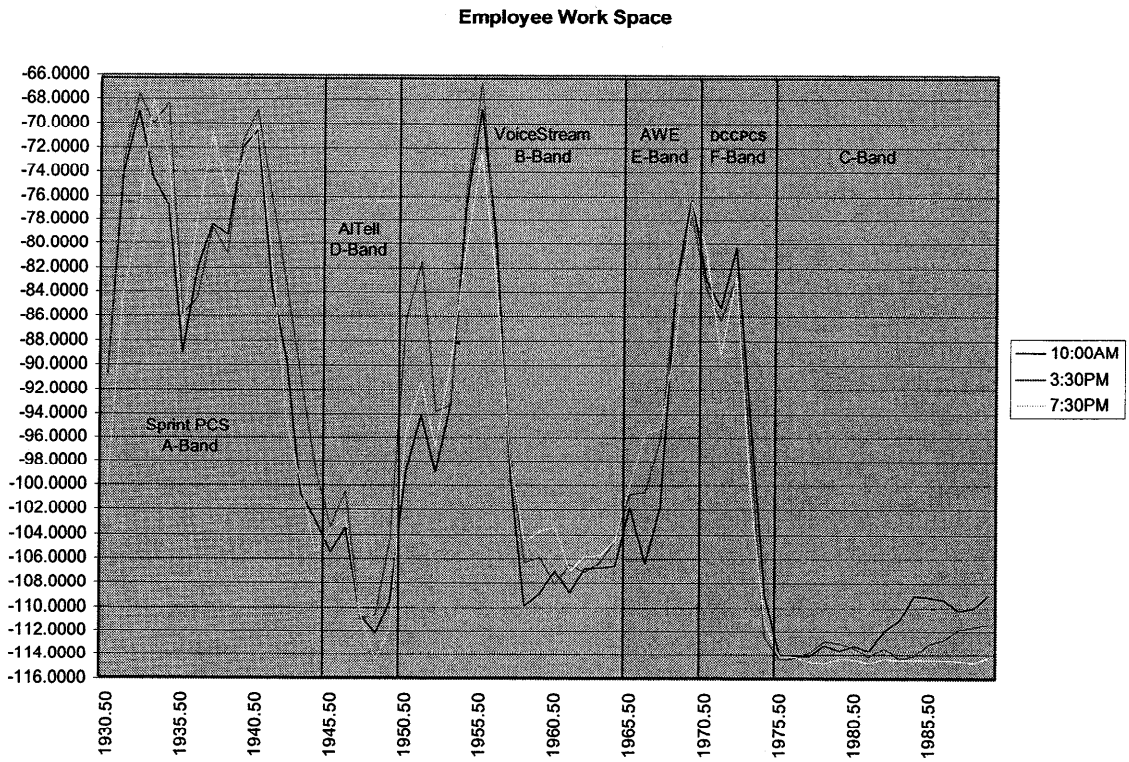

Figure 5: RF Signal measured in employee workspace

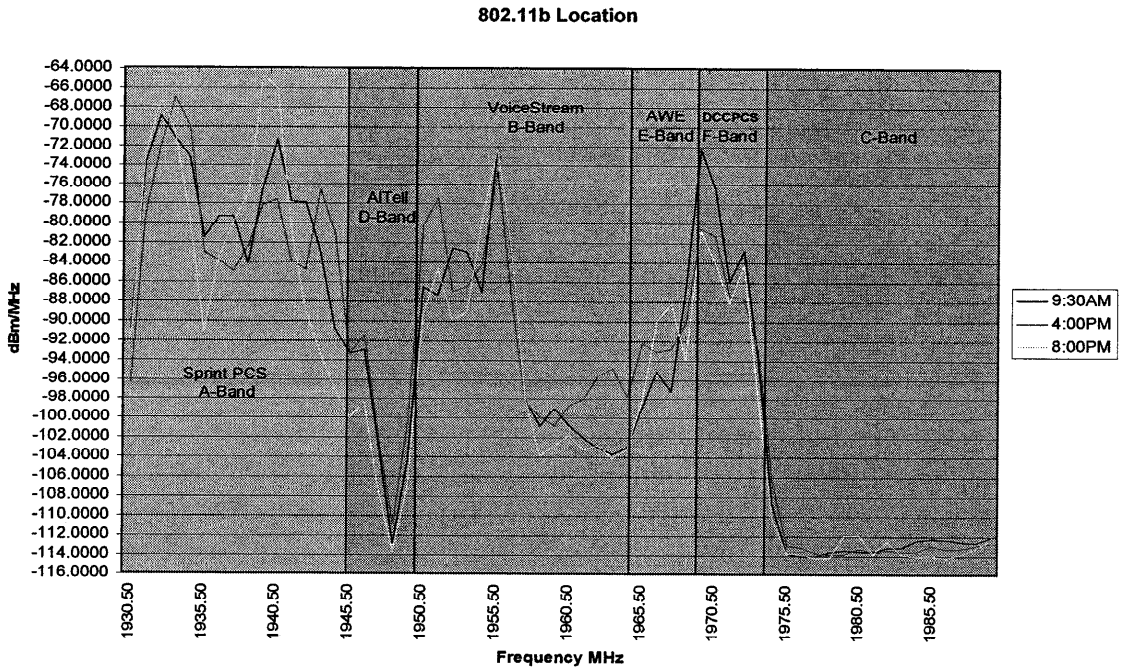

Figure 6: RF Signal measured in vicinity of 802.11b access point

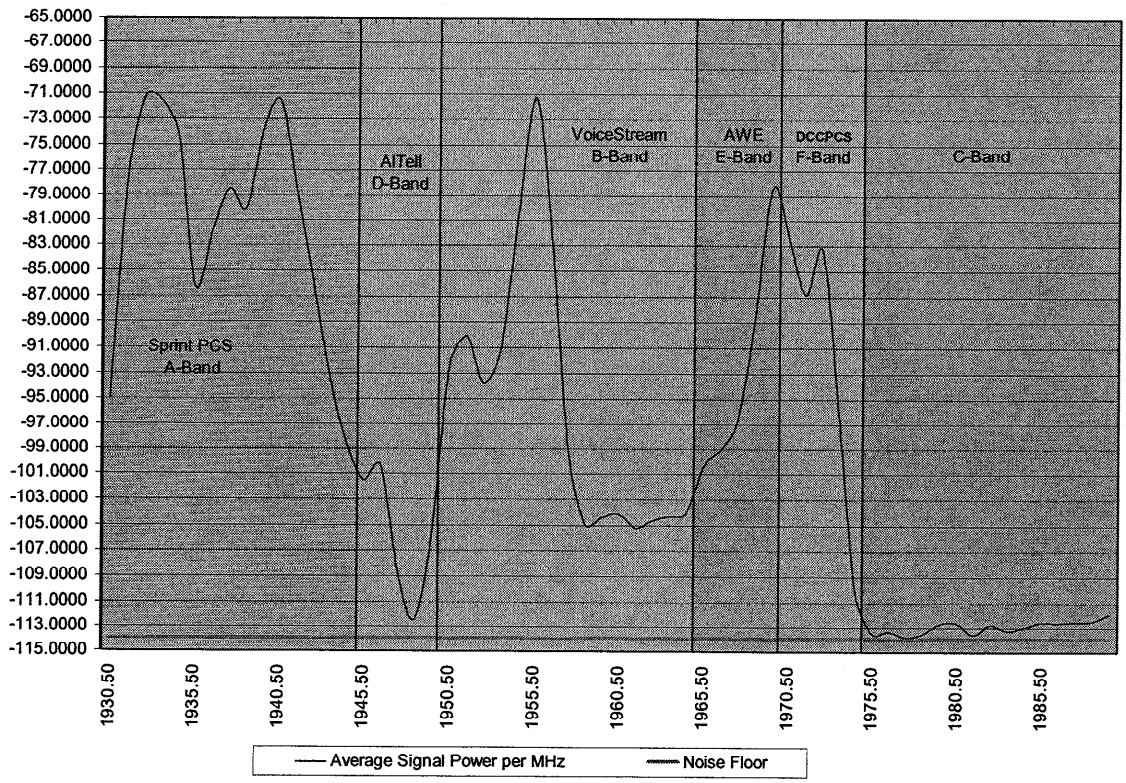

Figure 7: Average signal power across all measurement compared to the base line measurement

Ambient Measured Noise with Calculated UWB Emissions

Using the data collected from this evaluation and then calculating the proposed UWB limits at –41.2 dBm/MHz and –53.2 dBm/MHz plus three meters free space path loss, it can be shown that ultra-wideband operation would have a significant impact on the noise floor as previously measured across the PCS frequencies. These calculated results are superimposed on the measurements above and are reflected in Figure 8 below.

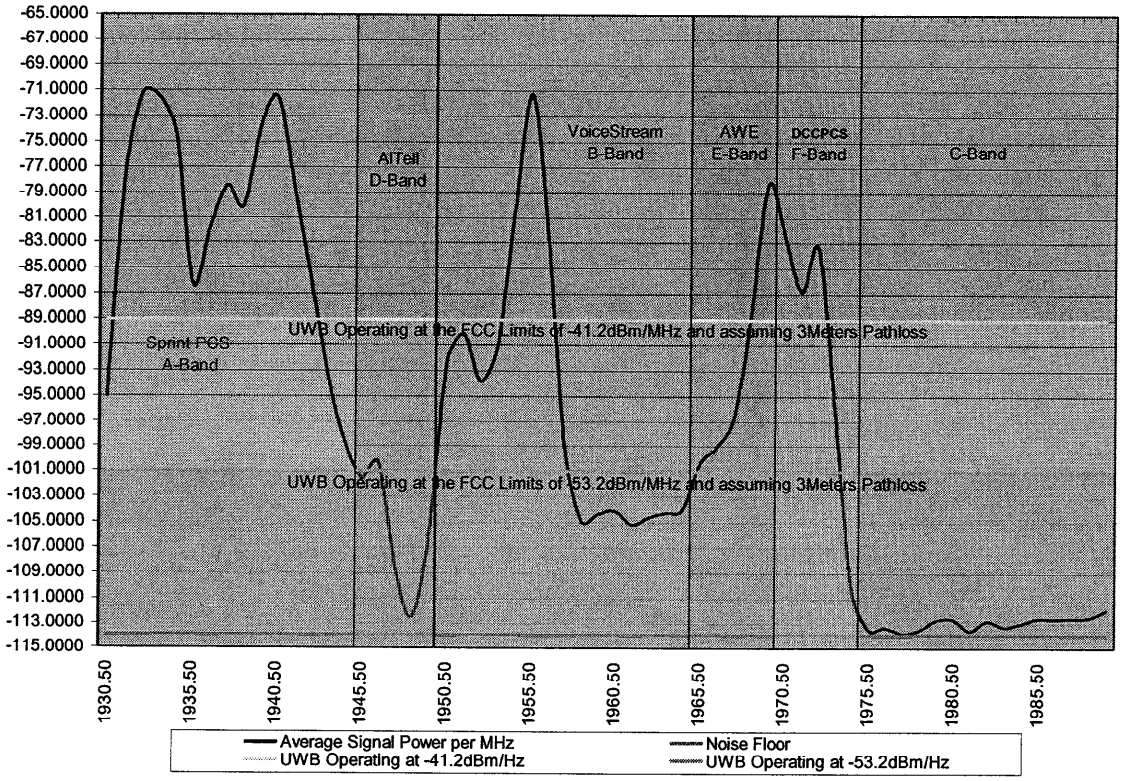

Figure 8:Calculated noise floor impacts with UWB operating at -41.2dBm.MHz and -53.2dBm/MHz and assuming 3 meter separation between the PCS receiver and the UWB transceiver

The data show a negative impact to the measured PCS noise floor by increasing the noise floor by 13 dB at –53.2 dBm and by 24 dB at –41.2 dBm. As previously shown in the Telcordia PCS/UWB model that Sprint PCS and Time Domain commissioned, an increase in the noise floor at these levels would result in a decrease in PCS air interface capacity and increase the probability of dropped calls.

Test Series 2 – Personal Computer RF Emissions

Additional data was gathered to determine the amount of RF energy generated by a Part 15 unintentional radiator device. For this exploration, an HP Vectra desktop computer with an Intel Pentium IV processor with a clock speed of 2GHz was used. This computer was chosen because it is a known device that operates near the PCS frequencies bands. The goal was to measure the amount of energy radiated from the device.

For the experiment, the computer was placed inside a Lundgren RF Shield box that provides 120dB of isolation from incident RF energy. An omni-directional antenna was placed on the inside of the enclosure and the computer chassis placed next to the antenna. The amount of separation between the antenna and the PC was negligible.

The test setup for this evaluation is shown in Figure 9 and the results of the measurements shown in Figure 10.

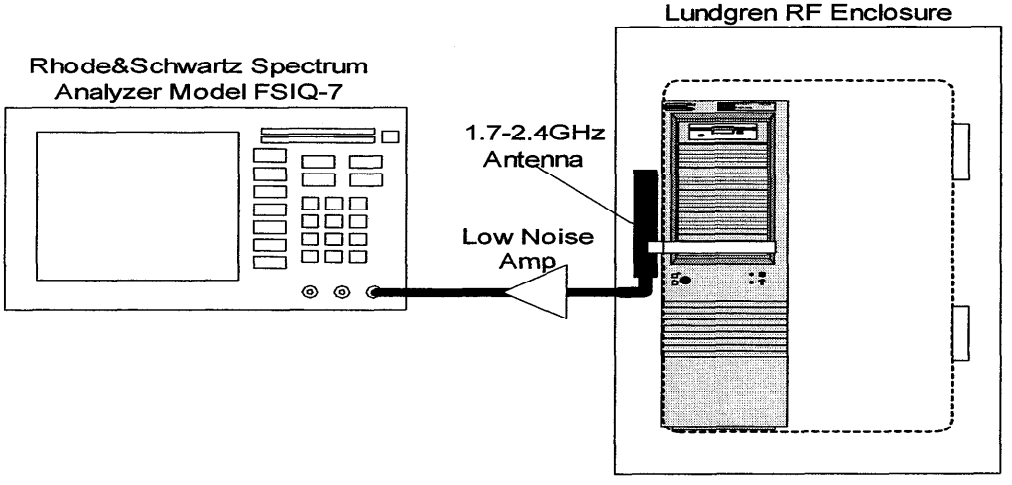

Figure 9: Test setup to measure the amount of RF energy created by a 2GHz Processor in a desktop computer

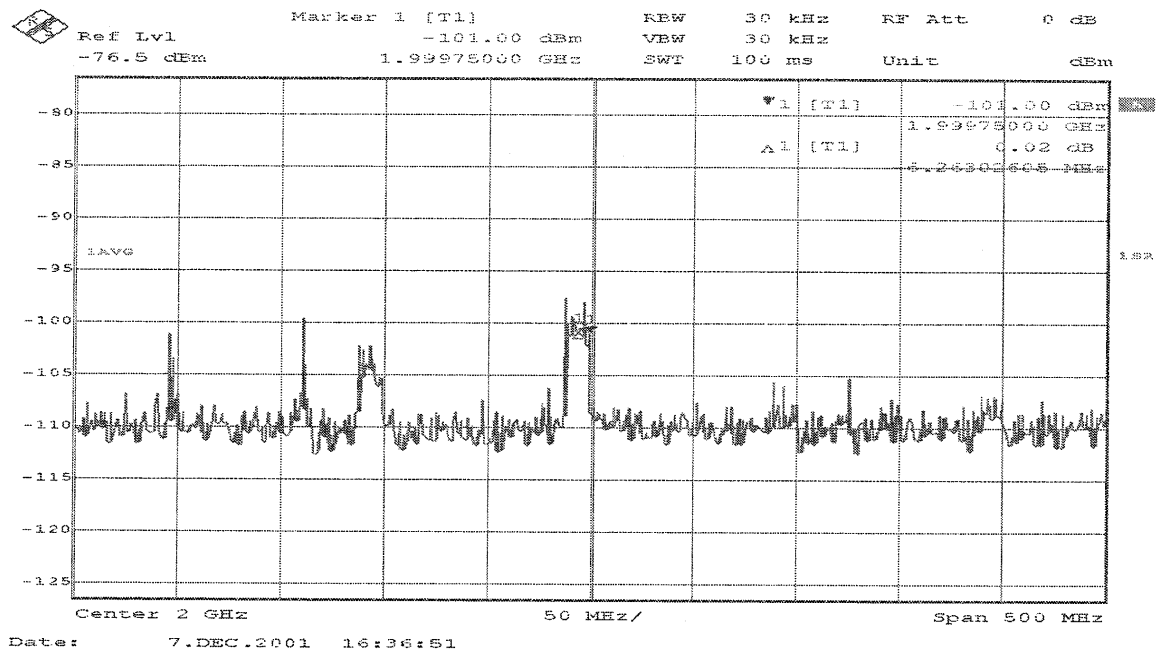

Figure 10: Spectral measurement of 2GHz Intel Processor in desktop computer with cover off

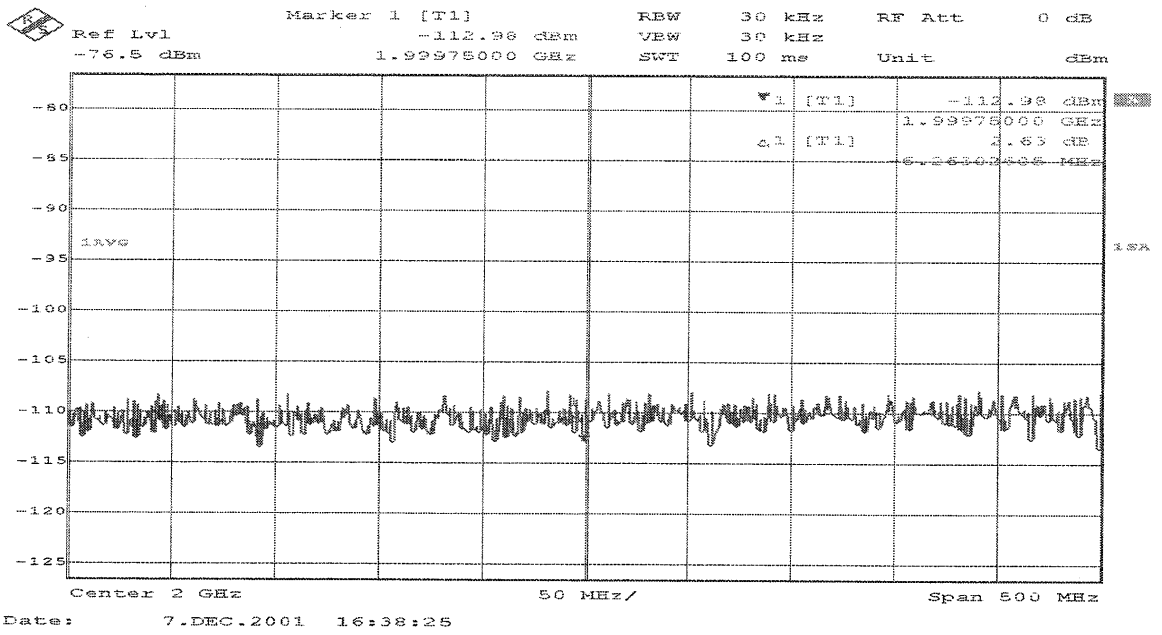

Figure 11: Spectral measurement of 2GHz Intel Processor in desktop computer

Figure 10 and 11 are interesting plots in that they show that for this particular device, the amount of shielding provided by the case eliminates any RF energy produced by the internal electronics of the computer. Equally significant, the amount of energy produced by this device with the cover off still remains below the FCC limitations for devices that unintentionally radiate radio frequency. For the device with the cover removed, the maximum amount of energy is -100 dBm/30kHz or equivalently, -84.77dBm/MHz when the source is less than six inches from the collection antenna. Assuming the FCC measurements that are made at a distance of three meters from the source, and assuming free space path loss at 2GHz, the resultant measured noise from the computer without its cover would be 48 dB below the -84.77dBm/MHz or -132 dBm/MHz, which is well below the measured noise floor established in Figure 3.

Figure 12 below illustrates the carrier-to-interference ratio (C/I) which is similar to the signal-to-noise ratio for narrowband technology. As a point of contrast, the measured noise generated by the 2GHz Pentium IV processor is below the existing noise level. The chart also show the calculated degradation that would occur if UWB devices are operated at or 12 dB below the FCC Part 15 limits for unintentional radiators. This degradation is calculated by using two UWB transmit powers, -41.2 dBm/MHz and –53.2 dBm/MHz, plus the associated path loss component for RF loss at 2 GHz. The resulting UWB noise levels are then presented as they could be received at a location three meters from the UWB transmitter. As Figure 12 shows, there would be significant reduction in the amount of C/I when in the vicinity of a UWB device, which would lead to a decrease in capacity, and an increase in the probability of dropped calls.

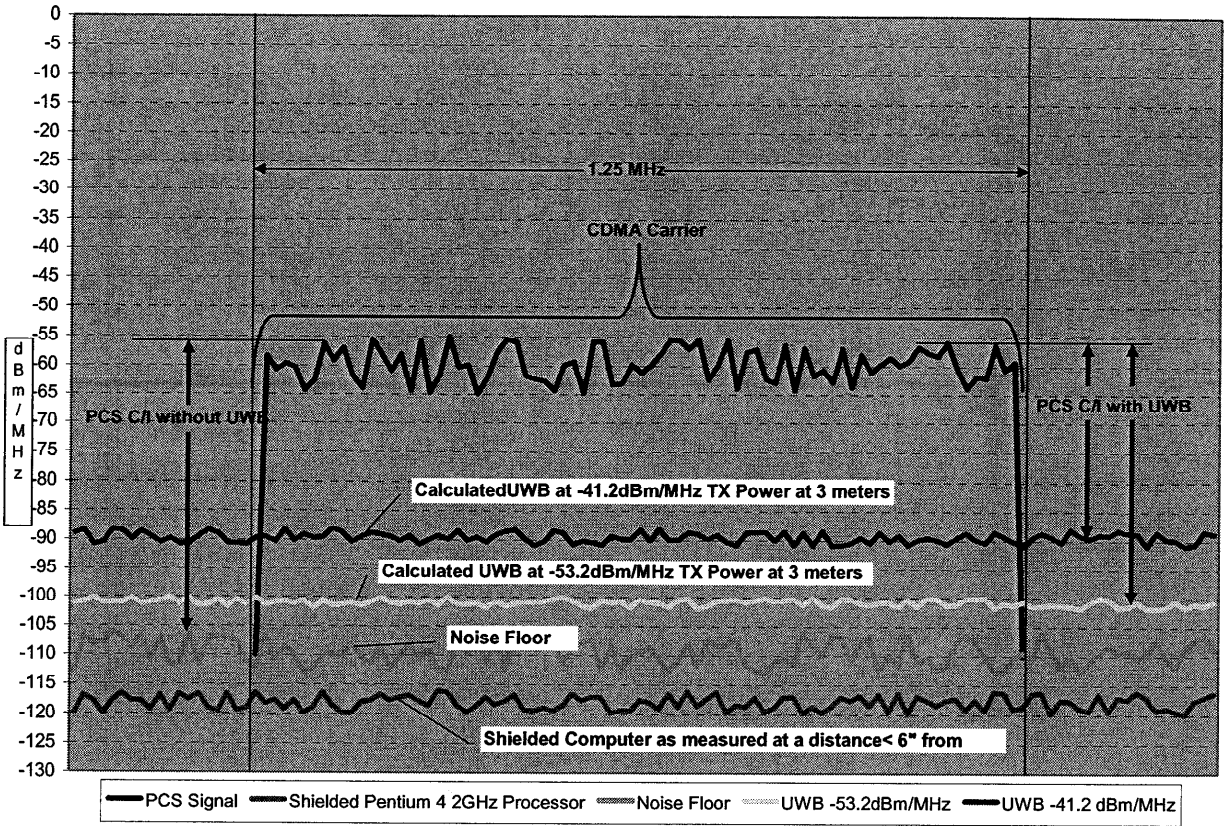

Figure 12: Pentium IV Spectral Impact v. UWB

Summary and Conclusions

Sprint PCS sought to measure the amount of energy that exists inside the PCS spectrum band that would be attributed to factors other than operation of wireless PCS services. In order to achieve this goal, measurements were made inside an office environment under real world conditions to validate if unintentional radiators, or microwave oven and Wireless LAN intentional radiators could be detected and, if so, what was their impact. Based on the data collected in the sampling, the investigation did not detect impacts on PCS frequencies from any of the other devices in the environment that fall under the Part 15 unintentional radiator rules. In addition, the wireless LAN and microwave oven operating within FCC rules for unlicensed use in the 2.4 GHz range generated no detectable impact. All of these devices operate well below the Part 15 limits and/or do not radiate energy in the PCS band. Furthermore, those devices such as wireless LANs and microwave ovens, that are known to radiate energy in unlicensed bands, do not have an impact on PCS licensed spectrum.

The second aspect of this evaluation was to determine the amount of energy radiated by a device that falls under Part 15 unintentional radiator rules and is known to operate near or in PCS licensed frequencies. For this portion, a 2GHz Intel processor in an HP Vectra computer was used to determine if the device was above, at or below the FCC limits. The data collected shows that when the device is operating with its cover on, the 2 GHz computer does not generate enough energy to be detected by the test equipment.

To put into perspective the impacts UWB would have on licensed PCS operations, Figure 8 shows that proposed UWB transmit powers would have a significant negative impact on the amount of carrier-to-interference ratio (C/I) currently engineered into PCS wireless networks. Allowing UWB operations at either of the levels discussed in the NPRM (-41.2 or -53.2 dBm/MHz) would result in a decrease in the call capacity in the radio portion of PCS networks (existing PCS networks could serve fewer customers) and increase the probability of dropped calls.